the utmost importance at certain seasons and forecasts cannot be accurately made from city temperatures thus affected. Shippers' forecasts should cover the terrain over which the shipment is transported, and should be verified from country and not city temperatures.

Visibility from a city office is like the proverbial "drop in a bucket" insofar as the surrounding country is concerned. From the aeronautical standpoint, it is of little value; in view of the present trend of aircraft, it may be some time before we land in the heart of cities to any great extent. Certainly this visibility cannot be used to determine questionable air masses.

Although only a few instances have been cited and the length of comparative records is short, it can be readily seen that smoke has a definite influence on the climatic features of Nashville. A similar problem will be found in a large number of our Southern cities and presents an item for further investigation.

ICE CRYSTALS AND HALO PHENOMENA

By B. W. CURRIE

[University of Saskatchewan, Saskatoon, Saskatchewan, Canada, March 1935]

Vertical pillars of light frequently are seen during the winter months above street lights, electric advertising signs, and airport beacons in Western Canadian cities.[1] These pillars are caused by reflection of light to the observer from falling ice crystals between him and the light source. Essentially this is a halo phenomenon, and one for which the form and the size of the ice crystals, and the accompanying atmospheric conditions, can be observed.

The color of the light from the pillars, and its state of polarization, show that they are caused by reflection. The color of each pillar is exactly the same as that of the light below it; the red pillars from the neon electric signs are particularly noticeable. The light from the pillars due to distant street lights shows no polarization, while the light from the top of the pillars produced by near street lights shows polarization in a vertical plane. Evidently, if the observer is close enough to a street light, a portion of the light forming the top of the pillar is reflected from the ice crystals at angles close to the polarizing angle.

Figure 1 shows an artificial light display. The apparent height of a pillar increases with the intensity of the light source. Calculations based on known distances to light sources and the measured sizes of the corresponding pillars on photographs often give heights in excess of 1,100 feet. When the wind velocity is greater than 8 to 12 miles per hour, only the brightest lights have pillars, and these are always low and faint.

Whenever the pillars are seen, the falling ice crystals are caught on a glass plate and photographed by transmitted light, a 1-inch microscope objective being used for a photographic lens. In this way images of 40 to 70 crystals are obtained by a single exposure, and these may be examined and measured later. Two kinds of crystals—thin hexagonal plates and thin broken fragments of snowflakes—cause the pillars. Only the first kind is found on calm nights when the most brilliant displays occur. Figure 2 shows several typical crystals. A tenth-millimeter scale magnified the same as the crystals indicates their size. The mean maximum distance between opposite sides of 61 crystals photographed at Saskatoon, Canada, on the evening of January 23, 1935, was 0.071 mm. Individual values ranged from 0.14 to 0.03 mm. Occasionally two crystals will freeze together (as shown in figure 2), and the thickness can be measured. The mean thickness of 18 crystals was 0.016 mm, extreme values ranging from 0.025 to 0.01 mm. Rounding of the edges due to melting will tend to make this value too large.

Both kinds of crystals may be found when the pillars are seen on windy nights. However, the second kind alone can cause the pillars. They are snowflakes broken by the wind, and are of many shapes and sizes; diameters below 1 mm predominate. Incidentally, pillars have never been observed when unbroken snowflakes are falling.

Hexagonal plates more than 0.1 mm across have been observed so far only once. This was on November 18, 1932, at the Canadian International Polar Year station near Chesterfield Inlet, when a brilliant pillar was seen above a light outside the Roman Catholic Mission Hospital. The mean diameter of the plates was 0.14 mm; extreme sizes ranged up to 0.8 mm. This was the only time during the year at Chesterfield that an artificial light pillar was observed, and was also the only time when an observed crystal fall consisted of plates alone. Generally the falls were a mixture of plates, needles, combinations of the two, and needles with pyramidal ends.

Observations show that the crystals which cause the artificial light pillars are also responsible for solar and lunar pillars, and 22° halos. If the moon is visible at the time of an artificial light pillar display, a faint pillar extending above and below the moon can be seen. A solar 22° halo and pillar were observed simultaneously at the secondary auroral station, 20 miles south of Chesterfield, on January 24, 1933. A 15- to 20-mile wind was sweeping the crystal cloud along the earth's surface, and the sun was just above the horizon. The upper portion of the 22° halo was seen as a circle projected on the sky, and the lower portion as a parabola projected on the earth's surface. The pillar above the sun was faint, and may have extended below the sun, but it could not be distinguished from the light reflected from the snow surface. Incidentally a distinct difference exists between the parabola [2] observed in this case and that frequently seen from frost formations or crystals on the earth's surface, the illumination inside the parabola being much brighter because of the light reflected from the snow surface. The crystals were found to be mostly thin plates when examined by the lens on the auroral camera (the only lens available). Their size was considerably less than 1 mm.

Weather conditions during artificial light displays vary greatly. Wind velocities less than 8 miles per hour seem essential to the formation of bright pillars. If snow is falling, the pillars can be seen only if the wind is strong enough to break the snowflakes. Temperature conditions show no uniformity, partly because the crystals are formed at higher levels and then fall to the surface. The temperature changes leading up to the two displays already mentioned contrast sharply with each other. At Chesterfield the temperature dropped 10.8° F. between 14 : 50 h.

[1] Nature, 1930, vol. 125, p. 526.

[2] Die Haloerscheinungen, by R. Meyer, pp. 73–74.

FIGURE 1.—Artificial light pillars.

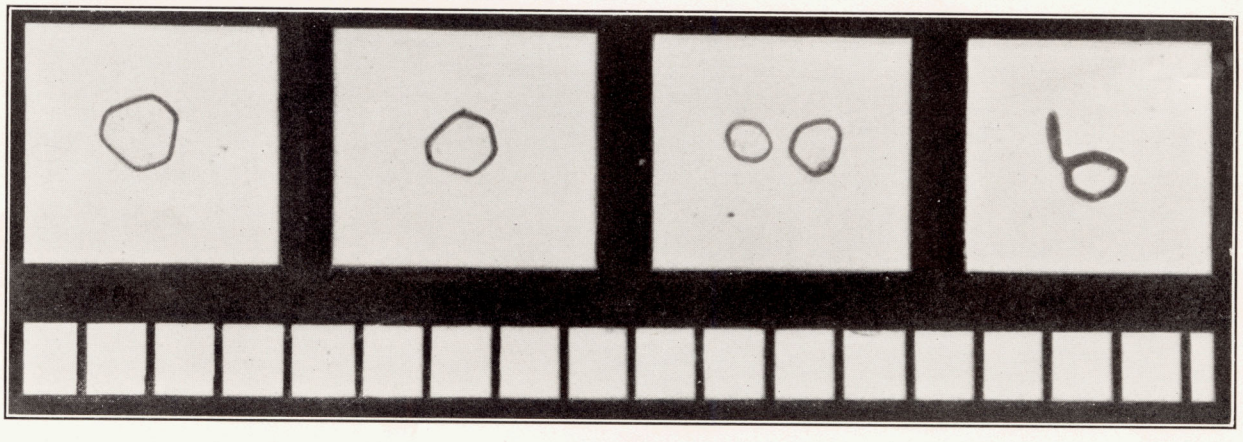

FIGURE 2.—Typical crystals.

and 20:00 h. L. M. T. and the relative humidity increased to 100 percent, remaining at that value during the display. At Saskatoon the temperature rose 28.5° F. between 06:00 h. and 20:00 h. L. M. T., and the relative humidity remained constant at about 100 percent. In the latter case warm, moist air was coming in, raising the air temperature, but was kept cooled to the dew point by the relatively cold snow surface. During the first display the mean temperature was 5.4° F., and during the second −12.0° F. Observations taken so far show that the smaller crystals are formed at the lower temperatures.

It seems reasonable to assume that more complex halos are formed around artificial lights, but that they cannot be seen because of the general illumination. If a strong source of light could be placed far from other light sources many of the usual halo formations might be seen, and the crystals and atmospheric conditions causing them could be studied.

FLOODS, EARTH AND SNOW SLIDES, AND AN ICE STORM, FROM UNPRECEDENTED PRECIPITATION IN THE STATE OF WASHINGTON, JANUARY 1935

By LAWRENCE C. FISHER

[Weather Bureau, Seattle, Wash., February 1935]

All previous-recorded 24-hour and 5-day amounts of precipitation in the State of Washington were exceeded during a period which began with snow on January 21, 1935; and station records were broken for a number of places in northern Washington. In the western part of the State the snow turned to rain on the 21st or early on the 22d; rain followed in the colder eastern part of the State to a considerable elevation in the mountains. To the west and south of the Olympic Mountains, which are in extreme northwestern Washington, the following precipitation amounts were recorded: At Quinault, 12.00 inches on the 21st (mostly rain) and 37.00 inches in the 5-day period beginning that day; Elkpark, 12.00 inches in 26 hours—the 5-day period was incomplete; Spruce, 11.59 inches on the 21st, and 29.92 inches in the five days; Wynoochee Oxbow, 9.47 inches on the 21st and 29.91 inches in the five days. Previously the greatest 24-hour amount in the State was 8.16 inches. The total for January, 50.39 inches, is the greatest ever recorded in any month at Quinault. However, this amount has been exceeded at other stations in the State, notably by the 57.04 inches at Cougar for December 1933. East of the Cascade Range, in western Okanogan and northern Chelan Counties, the fresh fall of snow on the 21st was remarkable: At Winthrop, 52 inches; Gunn Ranch, 48; Stehekin, 44; and Stockdill Ranch, 40. The 52 inches of freshly fallen snow at Winthrop is the greatest record in Washington. It reduced to 4.16 inches of water.

Prior to the 21st, cold air under high pressure had spread from Alaska to the Pacific Northwest, while a barometric depression developed marked intensity off the coast. At the time of this precipitation the principal path of the warm moist air from the ocean which flowed over the cold air, was across southern British Columbia and northern Washington. Excessive rains and melting snows made rushing torrents of the rivers in the hills and mountains of the northwestern counties, and the lowlands were flooded. Floods in the northeastern part of the State, however, were not serious, except in a few localities. Landslides occurred in many places where highways and streets had been graded, and on barren steep slopes. A number of snow slides were reported in the mountains. A 260 square mile sector of northwestern Whatcom County was visited by a very destructive ice or glaze storm, locally called a "silver thaw." This ice storm extended into Washington from British Columbia, and was caused by rain falling into a stream of cold air which was flowing down the Fraser River Valley from the very cold interior of British Columbia and (a part of it) into Whatcom County. It crossed the border in the region about Sumas moving west-southwest, missing Blaine on the north and Bellingham on the south. No temperature readings were made at Clearbrook from the 22d to the 24th, as the thermometer shelter was sealed by a coating of ice.

As a result of the severe weather conditions, four persons lost their lives. A man was buried in a snowslide in eastern Whatcom County, another was asphyxiated while keeping warm in his auto when entrapped between two snowslides in Snoqualmie Pass, and a woman and child were drowned near Burlington.

The total property loss, undoubtedly exceeding $1,500,000, was greatest in the northwestern counties. The things damaged or destroyed included bridges, highways, pavements, bulkheads, sewers, homes and furnishings, farm buildings and contents, hay, grain, farm implements, road equipment, cattle, horses, sheep, hogs, poultry, orchards, trees, shrubs, fall-sown grain, meadows, pastures, fences, telephone, telegraph, and electric light poles and wires. There also was erosion of farm lands, and deep deposits of silt, gravel, and debris; destruction of dikes, which permitted salt water to overflow fertile soil; interruption of transportation of passengers, mails, express, and freight; the local closing of schools, mills, logging and road camps; reduced production of dairy and poultry products, and local suspension of business.